Incorporating "The Illuminating Engineer."

# Light and Lighting

Official Journal of the Illuminating Engineering Society.

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## Principal Contents:



# "The Only Light in the Black-out"

UNDER this title *The Times* recently reviewed the fourth report of the Library Association, dealing with the county library service during 1938 (which incidentally is the twentieth year since the passing of the Act inaugurating these facilities). Of the rural population of Great Britain over 99 per cent. now have reasonable access to a public library as compared with 2½ per cent. in 1915. Stocks of books have risen to over 7 million. Issues to the public were made more than 50 million times during the year in review.

Fortunate indeed are those who get the opportunity, in these days, of attending and enjoying such a gathering as the recent opening meeting of the Illuminating Engineering Society (see p. 157), when the Presidential Address was delivered in the historic lecture theatre of the Royal Institution, and one recaptured the atmosphere of days when the pursuit of science could still be carried on in peaceful security. But such opportunities are now rare and few can benefit by them.

The deprivations of the war have served to bring about wider appreciation of the benefits of reading; some people, cut off from other enjoyments, have found a book "the only light in the black-out."

The absence of artificial light in the streets and other factors restricting movement have gone some distance towards undoing the social changes of the present century. In some degree they have put the clock back to those days when conversation was an art, reading a constant diversion, and a neighbourly visit an occasion.

In the march of progress occasioned by artificial light we have gained much but we have, perhaps, also lost something. "Reading," said Bacon, "makes a full man, conversation a ready man." Let us make the best of the present circumstances, which provide an opportunity of improving our proficiency in both respects.


## *I.E.S. Opening Meeting*

It was a great privilege for the Illuminating Engineering Society to hold its opening meeting in the lecture theatre of the Royal Institution on October 8, when Professor MacGregor-Morris delivered his Presidential Address on "The Arc as a Standard of Light."

The new President was introduced by Mr. F. C. Smith, who recalled that Professor MacGregor-Morris was amongst the Society's earliest members, having joined in 1909, its first year of existence. Professor MacGregor-Morris had participated in numerous investigations undertaken by the Society in the past—for example, those concerned with the testing of flares and star-shells during the last war, and subsequently with school lighting and the lighting of cinema theatre auditoriums.

Professor MacGregor-Morris, after taking the chair, moved a vote of thanks to the retiring President, Mr. F. C. Smith, for his unselfish, wholehearted, and able services to the Society during the past year. The vote was supported by Mr. Percy Good, who paid tribute to Mr. Smith's valuable aid in connection with A.R.P. lighting.

The subject of the Presidential Address was well adapted to the occasion, seeing that Sir Humphrey Davy's classic experiments on the electric arc were conducted at the Institution. The lecturer recalled the suggestion of Captain Abney, nearly sixty years ago, that, in view of its constant temperature, the crater of the carbon arc might serve as a standard of light, and the investigations of Mr. A. P. Trotter and others in this field. He himself expressed the belief that the "three-electrode arc" provides a possible basis for such a standard. Consideration of the possibilities of the arc as a standard is, however, affected by the existence of the "Trotter rotating comma," the strange whirling effect of the bright spot at the positive crater, which has been the subject of much research by the lecturer. The address, which will appear in full in the *Transactions* in due course, was illustrated by some striking and effective experiments. It represented in a sense a new departure, but it is all to the good for addresses to get off the beaten track occasionally, especially in such cases as this, when the lecturer is willing to record the results of original research and is able to illustrate his conclusions by such brilliantly executed demonstrations. The dignity and repose of the surroundings enhanced the impression and the welcome contrast with the turmoil of war.

In the course of the proceedings the Gaster Memorial Premium was awarded to Mr. Dunbar for his contribution entitled "Visual Efficiency in Coloured Light," which appeared in the *Transactions* of the Society for October, 1939.

## *New I.E.S. Local Sub-Centre in Coventry*

For some little time the idea of forming an I.E.S. local sub-centre in Coventry has been under consideration. The plunge in this direction was taken at a meeting on September 10, over which Mr. Howard Long presided. In an initial address Mr. Long briefly outlined the aims and objects of the Society and the steps leading to the decision to initiate this sub-centre. A representative committee was formed with Mr. F. C. Dain as chairman and Mr. J. W. Dainty as honorary secretary. There is already a good nucleus of members, to which substantial additions are expected as soon as meetings commence. No time has been lost in initiating a programme. The Chairman's address was arranged for October 14, and Dr. Hampton is to give an address and demonstration on November 11. Thereafter a social evening, a discussion on war-time industrial lighting, and a "problems" meeting will complete the programme. It certainly requires some courage to initiate a new local centre under present conditions, but in such matters there is nothing like confidence, and we congratulate members in Coventry on their enterprise and determination. We look forward to giving further reports of progress in this area from time to time. Meantime, prospective members in that area should get in touch with the honorary secretary (Mr. J. W. Dainty, 11, Butt-lane, Allesley, Coventry).

Reference to the above decision was made at the first meeting of the Midland Local Centre in Birmingham on September 13, when Mr. Howard Long presided. Subsequently Dr. W. M. Hampton gave an address on "Colour Recognition of Point Sources," which was illustrated by numerous lantern slides dealing with methods of research and explaining the applications of knowledge derived in connection with colour-signals on railways and elsewhere.

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## *Preparations for the Black Out*

In view of the approach of longer hours of darkness, we have been asked to remind owners of factories and commercial premises of the expediency of overhauling their arrangements for black out. Pamphlets on this subject, entitled "War Time Lighting Restrictions for Industrial and Commercial Premises" and "Factory Ventilation in the Black Out" are obtainable from the Stationery Office, and priced respectively 2d. and 3d. net. Attention may also be drawn to BS/ARP 31, mentioned in our last issue. Now is the time to improve upon makeshift methods hastily contrived under emergency conditions last winter—if this has not yet been done.

# I.E.S. Notices

*We have been asked to give immediate publicity in this issue to the following notices issued by the Illuminating Engineering Society in view of the fact that the next issue of the "Transactions" may be somewhat delayed, whilst matter intended for publication therein is being completed.—Ed.*

## APPLICATIONS FOR MEMBERSHIP.

**Elections Pending.**

At the general meeting on October 8 the names of the following applicants for membership were presented for the first time:—

SUSTAINING MEMBER:—

Lee, Beesley and Co., Ltd. .....Queen's Road, COVENTRY.
*Representative* .....Mr. R. E. Battersby.

CORPORATE MEMBERS:—

Addison, S. .....68, Sandhill Oval, Alwoodley, LEEDS.
Bond, W. A. .....88, Perry Hill Road, Quinton, BIRMINGHAM.
Dainty, J. W. .....111, Butt Lane, Allesley, COVENTRY.
Entwistle, E. F. .....371, Rochdale Old Road, Bury, LANCS.
Grapes, G. T. .....24, Regent Place, RUGBY.
Gregg, W. .....64, Betley Road, Reddish, Stockport, CHESHIRE.
Hull, J. N. .....14, Langton Road, RUGBY.
Hulse, R. .....41, West Hill Road, Kings Norton, BIRMINGHAM.
Little, T. H. .....56, Dalston Road, CARLISLE.
Lockwood, G. .....Kentisbury, Station Road, Balsal Common, WARWICKSHIRE.
Lowson, J. C. .....10, Elsee Road, RUGBY.
MacDiarmid, S. C. ...279, Clifton Road, RUGBY.
Mastley, A. J. .....2, Stamleigh Road, Gibbet Hill, COVENTRY.
Pritchard, C. J. .....20, Walton Road, LEAMINGTON.
Rigg, R. .....15, Gala Street, Riddrie, GLASGOW.
Rodger, G. E. .....19, Humberstone Road, COVENTRY.
Stewart, J. .....32, Fowberry Crescent, NEWCASTLE-UPON-TYNE.
Sharp, T. .....101, Bagington Road, COVENTRY.
Sinclair, J. S. .....69, Abercorn Road, COVENTRY.
Sayce, H. .....17a, Claredon Street, LEAMINGTON SPA.
Schofield, N. .....26, Reveril Road, SHEFFIELD 11.
Shercliff, F. .....138, Bills Lane, Shirley, WARWICKSHIRE.
Walton, E. C. .....13, North Park Grove, Roundhay, LEEDS 8.
Watson, J. C. .....192, Hyndland Road, GLASGOW, W.2.
White, H. C. .....14-16, Bridge Street, MANCHESTER.

COUNTRY MEMBER:—

Crabtree, F. N. .....69, Daventry Road, Cheylesmore, COVENTRY.

TRANSFERENCE FROM COUNTRY MEMBERSHIP TO CORPORATE MEMBERSHIP:—

Boagey, C. W. .....104, South Woodside Road, GLASGOW, N.W.
Ross, A. .....Blane View, Coltpark Avenue, Bishopbriggs, GLASGOW.
Wilsdon, J. .....4, Richmond Road, OXFORD.

Other applicants for transference to Corporate Membership recorded previously in "The Transactions" (Vol. V., No. 6, July, 1940, p. 88) were also presented.

**Election Completed.**

At the general meeting on October 8 the following applicant, whose name had been previously presented at the general meeting on May 7, was declared a member of the Society:—

CORPORATE MEMBER:—

Duncan, N. L. .....Electricity Offices, Dockfield, Shepley, YORKS.

## I.E.S. FELLOWSHIP.

The Board of Fellows of the Illuminating Engineering Society has recommended the election of the following as Fellows of the Society, and this recommendation has been approved by the Council:—

Allderidge, C. J. .....10, Boscobel Road, WALSALL.
Caunt, C. S. .....62, Thackerays Lane, Woodthorpe, NOTTINGHAM.
Gostt, A. W. .....61, Lonsdale Drive, Enfield West, MIDDX.
Head, O. W. .....3, Bernard Avenue, West Ealing, LONDON, W.13.
Lewzey, L. G. .....32, Battledean Road, Highbury, LONDON, N.5.
Nisbet, Thos. ....."Eildon," West Brae Road, NEWTON MEARNS.
Norden, Konrad .....10, Westbourne Crescent, LONDON, W.2.
Penny, A. G. .....33, Denman Drive, Golders Green, LONDON, N.W.11.
Pyser, M. E. .....Central London Electricity, Ltd., 25, Eccleston Place, Belgravia, LONDON, S.W.1.
Raphael, F. C. .....Napier House, 24-27, High Holborn, LONDON, W.C.1.
Tye, L. M. .....52, Combemartin Road, Southfields, LONDON, S.W.18.
Watson, A. G. .....The Gas Accumulator Co. (U.K.), Ltd., Beacon Works, Brentford, MIDDX.

## NORTH MIDLAND CENTRE

A complete programme of meetings in Leeds, available to members interested, has been issued by the North Midland Centre. The leaflet also contains the particulars of the constitution of committees and a report of activities for the past session.

## NOTTINGHAM SUB-CENTRE

At a meeting held in the Demonstration Theatre of the City of Nottingham Gas Department, on September 27, Mr. F. Walker, the retiring chairman, introduced Mr. Professor H. Cotton, the chairman for the present Session, who delivered an address on "The Nature of Light." After dwelling on the speculations of ancient philosophers, Professor Cotton discussed in turn the corpuscular and wave theories of light, illustrating his remarks by experiments on interference and diffraction, etc. The final portion of the lecture dealt with spectra, and in particular the spectra of modern illuminants such as electric discharge lamps—the lecturer pointing out that these phenomena were most readily explained by a modification of the corpuscular theory. A cordial vote of thanks to Professor Cotton terminated the proceedings.

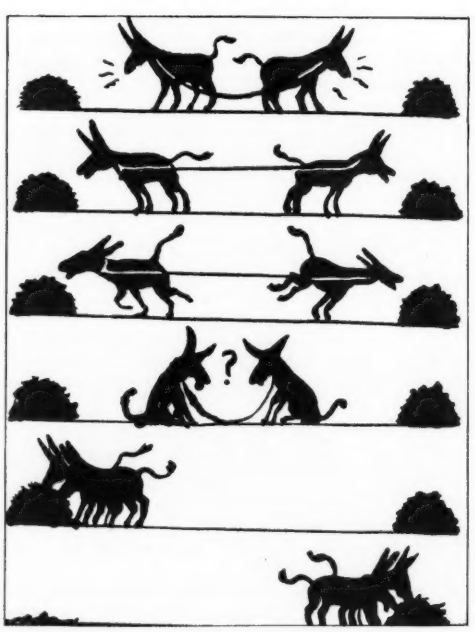
In conclusion, it was announced that forthcoming meetings would be held at 5 for 5.15 p.m.

### MEETINGS AT 2.30 P.M. IN LONDON

I.E.S. members are asked to take note of the fact that the time of meetings held in London has been altered since the issue of the programme in the last number of the "Transactions" (Sept., 1940, p. 122). Until further notice meetings will be held at **2.30 p.m.**—a time designed to allow opportunities for members residing at a distance to make their way homewards before the black-out and the accompanying nocturnal disturbances begin. This decision is doubtless the only possible one under present conditions. It has the drawback of cutting into normal business hours, but as the number of meetings in prospect in London only averages one per month this is not a very serious consideration. We hope, therefore, that firms interested in the Society will make arrangements to release members of their staffs whenever possible.

The **Next Meeting** will take place at **2.30 p.m.** on Tuesday, **October 22**, at the E.L.M.A. Lighting Service Bureau (15, Savoy-street, London, E.C.2), when Mr. H. C. Weston will read his paper on "Industrial Lighting in War Time."

## The Advantages of Co-operation



Our attention has been drawn to the above amusing illustration which we understand recently appeared in the house journal issued by Kodak, Ltd. The picture is self-explanatory and the moral one that will appeal strongly to illuminating engineers.

## Reviews of Books

*The Heating, Ventilation, and Lighting of School Buildings. By W. Douglas Seymour. (Oxford University Press, London, 1939: pp. 214, figs. 52. 12s. 6d. net.)*

In a preface to this work Dr. C. S. Myers, of the National Institute of Industrial Psychology, explains that it covers researches which originated in 1931 when the National Union of Teachers requested the Institute to investigate working conditions in schools. The results of researches subsequently undertaken and reviewed by the author of this volume have been published at the desire of the Association of Directors and Secretaries for Education. The book falls essentially into two portions dealing respectively with heating and ventilation and with natural and artificial lighting. It is thus of special interest to members of the Illuminating Engineering Society, whose attention was drawn not long ago to the necessity for joint study of these two amenities.* In Part I. previous work on heating, for instance that of the New York Commission, is reviewed, and an instructive account is given of researches conducted in schools in Essex. The three initial chapters of Part II. are devoted to natural lighting. A helpful review of essential conditions and the prediction of daylight factors by calculation and by graphical methods is given. A summary of recommendations concludes with the advice that a minimum factor of 2.0 per cent. should be maintained and measures taken to ensure that a value of 1.0 per cent. is always exceeded. In regard to artificial lighting the values specified by the Board of Education, the Illuminating Engineering Society, and other bodies are compared and appear to be generally similar. Attention is also drawn to quality (diffusion, absence of glare, etc.) and to certain special requirements of technical colleges. Useful references are given at the end of each chapter, and there is an adequate index. In many respects a useful treatise on this special subject.

* See "Illumination Levels and Comfort Conditions," by F. C. Smith (Trans. Illum. Eng. Soc., Vol. III., July, 1938, p. 95.)

# The Reds and the Greens

## (or, Coloured Light the Rebel Against Order in Photometry)

By JOHN W. T. WALSH, M.A., D.Sc.

*"What is truth?" said jesting Pilate, and would not stay for an answer.*—Bacon.

"Seeing is believing," said the Plain Man one night to his friend Perkin G. Smith, as they were walking home after a late spell of duty.

"Oh, is it?" replied Smith. "I'm not so sure. Haven't you noticed that when those green traffic lights are on, the pavement here looks quite bright and you can read your watch without any difficulty, but as soon as they change to red the whole place seems to go dark?"

"Yes, I certainly have, and it seems to me a very stupid arrangement not to have them more nearly equal."

"But they *are* equal," cried Smith. "Look at the lights themselves. You can see at once that the clear crosses are the same size and about equally bright, and I happen to know that they *are*, roughly, the same."

"Well, then, how do you account for the difference on the pavement?" queried the Plain Man, and his only answer was a subdued rendering of a familiar air which recalled to his mind the words of Buttercup's cryptic warning to the Captain of H.M.S. Pinafore.*

"That's all very well," commented the Plain Man, rather crossly, "but either two things are equal or they are not, and I can see very well that the brightness of this pavement under the green light is *not* the same as its brightness when the lights are red, so it's no use your telling me that it is."

"But I certainly never said anything of the sort," protested Smith. "What I said was that the lights themselves were equal; but I quite agree with you that the effects they produce as regards the brightness of the pavement are most unequal."

"Well, it's all very puzzling to a Plain Man, I must say."

"Yes, I suppose so; but after all that is only because we are so used to dealing with things we can weigh in a balance or measure with a tape. If we take a ton of sugar and a ton of sand and then divide each ton into 2,240 equal parts, we know that one part of the sugar will weigh the same as one part of the sand. But when it comes to illuminating a surface with lights of different colours matters aren't so simple by any means, because the eye doesn't treat the different colours with the same fine impartiality that our balance displays to everything that is weighed on it. The eye acts, in fact, as though it becomes more and more partial to greens and blues (or, if you like, more and more blind to reds and ambers) as the brightness gets less and less."

"Well, that's a new one on me," commented the Plain Man, "and I had no idea our eyes behaved in that ridiculous fashion."

"No more ridiculous than the Chancellor of the Exchequer, my dear Plain Man," said Smith, with apparently sublime irrelevance.

"The Chancellor of the Exchequer! Why, what on earth has he to do with it?"

"Oh, nothing, really, only it just occurred to me that we might all be very much upset if his idea of an equal sacrifice for all was an equal fraction of everyone's income. You see, our whole difficulty arises from the fact that we unconsciously tend to assume that the ordinary processes of addition and multiplication must apply to everything, whereas a moment's reflection would show us that they don't. However, perhaps we are straying from the subject, and, anyway, this is where I say 'good-night.'"

* * * * * *

Next week the two friends met again at the Post, and at the first opportunity Mr. Smith fished out of his pocket some postage stamps which he had brought to show his friend the P.M.

"You remember," said he, "our chat last week on the subject of the red and green traffic lights? Well, here are a couple of foreign stamps that may interest you. They were issued in 1937 by Czecho-Slovakia to commemorate the jubilee of a Johnnie named Purkinje. He carried out a lot of experiments on vision and was the first to notice—or, at any rate, to draw attention to—the curious effect we were discussing about the red and green traffic lights.

"As a matter of fact, I saw rather a neat demonstration of it the other evening at a meeting of a society I belong to: I wish you had been there. The chappie who was talking—a fellow named Preston, I think—had two large, flat boards painted with some of this stuff that glows under what they call 'invisible light.' One board was red and the other was a bluish green. He started off with the lamp giving the invisible light right at the back of the hall, so that neither board gave enough glow for it to be seen. Then, as he brought the lamp up the centre gangway towards the platform, the blue-green board started to show up long before the red. In fact, it was getting quite strong by the time the red had just begun to glow. Then, as the lamp was brought still nearer and nearer to the boards, the red began to catch up with the blue until, finally, you couldn't say for certain which was brighter."

The Plain Man looked at the stamps for a few moments.

"So old What's-his-name noticed that effect half a century ago," said he, "yet I don't suppose there's one person in a thousand to-day who knows any more about it than I did, or who has even so much as heard of him. However, the Czechs seem to be proud of the old man, and it was a bright thought of theirs to make one of the stamps red and the other green, wasn't it? By the way, my acquaintance with the Czech language is strictly limited, and the spelling on the stamp doesn't help me much. How do you pronounce his name?"

"Well, most Englishmen call him Perkin G. (not that he's any relation of mine), but that's not correct, really. About the nearest we can get to it is Perkin-ye, but as he wrote for a scientific periodical published in German, the Czech spelling was changed to Purkinje, which gives about the correct sound in German. Then the German spelling got

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*Things are seldom what they seem,
Skim-milk masquerades as cream,
Highlows pass as patent leathers;
Jackdaws strut in peacock's feathers.
Very true; so they do.

into the English literature on the subject, and so the name was anglicised with a fine disregard of its original form."

The Plain Man's attention was clearly wandering by the time his friend had come to the end of this rather involved explanation, and there the subject dropped.

* * *

I must confess to a good deal of sympathy with our friend the Plain Man. Certainly, it is most puzzling to those of us who are used to dealing with things capable of being measured by ordinary mechanical means to be brought suddenly up against a case where although A and B look equal, yet $\frac{A}{100}$ certainly does not look equal to $\frac{B}{100}$. We might, indeed, be tempted to dismiss photometry as an inexact science, or, perhaps, not a science at all, but this would be a mistake. In fact, so long as the brightness of the surfaces we compare is high enough the trouble does not arise. For instance, if the brightness is not less than that of white paper under an illumination of 1 ft.c.* there is no difficulty, and the ordinary rules of addition and multiplication can be applied.

Of course, the comparison of a red surface with a green one is always rather an unsatisfactory process, and colour difference has remained the bugbear of photometry ever since the pioneering days of Bouguer and Lambert. As Bouguer rightly remarked in 1760: "La comparaison de deux lumières de différents couleurs est . . . embarrassante" ("Traité d'Optique," p. 50); and Lambert, too ("Photometria," §309), laments: "Aegre comparantur claritates, quae colore plus minusve differunt." Nevertheless, while different observers differ, sometimes quite widely, in their judgments, there is, on the whole, sufficient consistency to justify the universal adoption (as a working convention) of a table or a curve giving the relative values assigned by the "average" human eye to equal amounts of energy at all parts of the visible spectrum. The essence of this convention is the fact that these relative values "stay put" when the intensities are altered, so that if, for instance, a certain red surface is found by the "average eye" to have a brightness equal to that of a certain green surface when the illumination of both is the same, the equality of brightness is not destroyed by any change in the value of this common illumination. Down to the limit of brightness mentioned earlier (1 eq. ft.c.) this essential condition is fulfilled quite satisfactorily, and even below it (e.g., at 0.1 eq. ft.c.) the departure is not easy to detect. It is only when we get down into the regions of brightness, or rather dimness, which have now become so common, that we find ourselves in difficulties.

This accounts for the unfortunate fact that there was until quite recently no agreement as to the way in which low brightnesses should be measured. Every photometrist knew quite well that the problem existed, but as it didn't come into his everyday work he was content to ignore it as probably of no more than academic interest. He was quickly shaken out of his complacency when a committee of the Illuminating Engineering Society and the British Standards Institution began to draw up a specification for the performance of phosphorescent and fluorescent materials.

These materials are of many different colours, and under normal conditions of use a brightness of 0.001 eq. ft.c., or even 0.0001 eq. ft.c., may well be of value. In the absence of any marked colour such a brightness is most easily measured by means of an ordinary portable photometer provided with a special neutral filter of low transmission, say one-hundredth or one-thousandth. The photometer is sighted at the surface to be measured, and the reading at the point of balance is first converted from illumination in foot-candles to brightness in eq. ft.c.*, and the result is then multiplied by the transmission factor of the filter, which is, of course, inserted so as to reduce the illumination of the comparison surface inside the instrument.

In the case of most phosphorescent or fluorescent materials the surface to be measured is not white but coloured, and then the temptation is to insert a colour filter in the instrument so as to obtain a colour match, the readings being, of course, multiplied by the transmission factor of the colour filter for white light. Assuming that this transmission factor has been determined in the usual way, viz., by means of measurements made at ordinary brightness levels, it will be found that the results obtained are very disconcerting. Not only do they fail to agree with measurements made when the observer does his best to obtain a brightness match without a colour filter (ignoring the colour difference as far as possible), but, what is far worse, in many cases they contradict the verdict of ordinary observation by the "man in the street." For instance, it may well happen that a green surface which, when measured in this way, is found to have a brightness of 0.001 eq. ft.c. appears far brighter than a red surface which also measures 0.001 eq. ft.c. In fact, it will be obvious that this must be so on account of our old friend the Purkinje effect, for the insertion of the low transmission neutral filter, by bringing the brightness down to a low figure, gives the green a great advantage over the red.

It is clearly of no use for the photometrist to say, "These surfaces give the same reading on the photometer and, therefore, they must be equally bright." The man in the street will simply reply, "That is nonsense, because anyone can see for himself that the green surface is very much brighter than the red, and no one who isn't blind would say differently."

The only thing to be done is to accept the facts as they are and to agree to define equal brightnesses as those that appear equal to the average observer. This means, of course, that if we define 0.001 eq. ft.c. as one-thousandth of 1 eq. ft.c. for white surfaces, then for a green surface 0.001 eq. ft.c. is *less* than one-thousandth (perhaps about half a thousandth†) of 1 eq. ft.c., while for red it is *greater* (perhaps about one or two hundredths†). Further, since the Purkinje effect does not occur suddenly at one particular brightness level, but gradually increases as the brightness falls from about 0.3 eq. ft.c. to 0.001 eq. ft.c., it is not possible to determine a simple factor for each colour which will apply at all levels of brightness that are practically important.

All that we can do, then, is to say that the scale of brightness shall be defined by means of white surfaces‡, and that the brightness of all other surfaces shall be determined by visual comparison with a white surface. Thus, if a green surface appears to the average observer to be, as nearly as he can judge, neither darker nor lighter than a white surface having a brightness of 0.05 eq. ft.c., then the brightness of the

* It has, alas, become increasingly popular to use as the unit of brightness the *equivalent foot-candle*, which is defined as the brightness of a white diffusing surface of 100 per cent. reflection factor when its illumination is 1 ft.c. No one has been able to explain satisfactorily in what way the brightness is "equivalent." The term has apparently followed the example of Topsy, and, to the grief of many, it has gate-crashed into the literature, all protests and counter-suggestions notwithstanding.

* This is done by multiplying the reading by the conversion factor stated (see B.S.S. for Portable Photometers, No. 230—1925, Clause 5).

†The actual values naturally depend to some extent upon the particular parts of the green and red portions of the spectrum which we are considering.

‡For greater precision, the particular "white" adopted has been defined as light of colour temperature 2360° K. In effect, this means a colourless surface, e.g., magnesium oxide, illuminated by a tungsten filament vacuum lamp.

green surface is also 0.05 eq. ft.c., and the same applies to a red surface or one of any colour whatsoever.

Sometimes the brightness defined in the way just described is called "apparent brightness," to show that it has not been measured by a simple mechanical reduction (e.g., with a neutral filter or a sector disc) of a much higher brightness, one which is above the limit at which the Purkinje effect begins, and which can therefore be measured in the usual way.

There are still one or two snags which have to be avoided when making measurements of apparent brightness. These, again, are due to the peculiar behaviour of the eye and the way in which it is constructed. When we are in the dark or near-dark, the pupils of our eyes are fully dilated so that their intake of light is at its maximum. This condition should be reproduced when brightnesses are being measured, and therefore we must be careful that no eyepiece in the measuring instrument acts as an artificial pupil cutting down the amount of light which enters the observer's eye. The maximum diameter of the natural pupil is about 8 mm., so that no artificial pupil should have a diameter of less than, say, 9 or 10 mm.

The other snag is less obvious. The sensitive surface in our eye, the retina, upon which is focused the image of any scene we are looking at, has near its centre a tiny supersensitive portion called the *fovea*, and when we gaze straight at a small object we automatically turn our eyes so that the image of this object falls on the *fovea*. Now at the *fovea* the Purkinje effect either does not occur at all or only to a very small extent, and therefore if we are looking at two small surfaces side by side, one green, say, and one white, we shall not get the same result as if the surfaces were large. For this reason it has been specified that in making measurements of apparent brightness the surfaces shall subtend an angle of at least 10° at the observer's eye. This corresponds to a disc of 6 in. diameter looked at from a distance of just under 3 ft.

# Tunnel Lighting

The lighting of tunnels and subways presents problems almost unique in illuminating engineering, owing to the need to allow for accommodation of the eye in passing from darkness to daylight, and vice versa.

Taking first the conditions prevailing during the daytime it is evident that there is a wide gap between the value of natural lighting out of doors and that of the artificial lighting within the tunnel. It is desirable to make the transition gradual so that the eyes of drivers may not be affected by the abrupt change. Recent researches, summarised in the "Electrical World," suggest that an illumination of the order of 200 ft.c. should be provided near the mouth of the tunnel. In the case of the vehicles travelling at 50 m.p.h. the diminution in illumination to the value of 2-3 ft.c. should be spread over a distance of about 50 yards, and should be spread over a still greater distance if higher speeds of traffic are contemplated.

Exactly the reverse problem is encountered at night. Under normal conditions when the tunnel connects with a well-lighted main street the contrast is very much less than in daylight, and an alternative system of lighting to meet these conditions can readily be contrived near the tunnel entrance. The contrast is, however, much more severe under "black-out" conditions when the recovery of the dark adapted eye is relatively slow. Therefore, in this case the alternative "dark to light" transition requires more careful study.

# Photometer for Testing Motor Car Headlights

The simple Bunsen or grease spot photometer screen has definite advantages, being light and simple and also, if skilfully made, highly sensitive.

A recent instance in which it proved useful was the preparation of a simple device for testing compliance of motor-car headlights with the Lighting Restrictions Order. What is needed here is a simple method of ascertaining wherever a headlight does, in fact, give much more light than the prescribed, i.e., 2.5 foot-candles at a distance of 10 ft. Great accuracy is not needed if it be assumed that the test is only applied as a basis of warning and would be supplemented by more accurate examination in doubtful cases. The apparatus consisted of a small glow lamp, supplied with current from a small dry battery, placed inside a box with a whitened interior.

The lamp is mounted near one side of the box. A screen is inserted between the lamp and the opposite side of the box, in which a hole is cut to receive the grease spot screen. The latter is thus only illuminated by diffusely reflected light coming from different directions. By this means one of the weaknesses of the grease spot—a tendency for the "balance" to vary according to the angle of view—is very largely eliminated. In this case the photometric screen consisted of an opaque white central disc with a surrounding greased annulus, illuminated by transmitted light. The central spot thus appears brighter than its surround when the illumination to be measured is in excess of the test value. By inserting a wedge of translucent material between the lamp and its background it is possible to adjust the brightness of the spot so as to get a correct reading or to reset it after calibration from time to time.

For the purpose in view great accuracy is not required, as action would only be taken if the central spot was obviously very much brighter than the surrounding area, showing that the candle-power of the headlight was manifestly too high. The device can be quite easily assembled. A specimen was, in fact, prepared by Mr. P. Crawford Sugg within a few hours of the receipt of a suggestion from the committee concerned, and its utility was clearly demonstrated.

## Photoelectric Cells

Readers may be interested to learn of the photoelectric cells now being offered by Arthur B. Evans and Co., Ltd., particulars of which are announced in "Where to Buy" (p. 173). Charts are available showing the characteristics of these cells, for which a high degree of stability and a relatively close approach to the spectral sensitivity of the eye can be secured. There have, however, been further recent developments, and cells having almost all widely different characteristics, so as to satisfy almost all conditions, can now be obtained.

## War-time Street Lighting with Gas

Successful experiments having been carried out at Lincoln with low-power street lighting, it has been decided to extend the system to the whole of the city's main thoroughfares. Most of the four hundred lamps will be gas-lighted.

Lisburn District Council is considering the installation of gas "starlights" in the streets.

# Literature on Lighting

## (Abstracts of Recent Articles on Illumination and Photometry in the Technical Press)

*(Continued from page 150, September, 1940.)*

### III.—SOURCES OF LIGHT.

**190. New Searchlight Uses Capillary Lamps.**

*Anon.* El. World, 113, p. 1,736, June 1, 1940.

A description is given of the use of water-cooled H.P.M.V. lamps in a searchlight. Three 1,000-watt lamps are used, to provide a beam intensity of 25 million candles. S. S. B.

**191. Carbon Arc for 16-mm. Film.**

*W. W. Lozier and D. B. Joy.* J. Soc. Mot. Pict. Eng., Vol. 34, p. 575, June, 1940.

The development of a carbon arc for projecting 16 mm. film is described. The colour quality has been matched to correspond more closely to incandescent tungsten than does a normal high-intensity arc, because 16 mm. colour film is at present always processed to give a true rendering with incandescent tungsten light. The maximum brightness of the crater is about 350 candles/sq. inch. The appropriate optical system in conjunction with the arc gives three times as much light on the screen as has hitherto been available for 16-mm. work. R. G. H.

**192. Fluorescent Lamp for Surgical Instrument Forge.**

*Anon.* El. Times, 98, p. 138, August 22, 1940.

The production of surgical instruments involves manual forging operations for which the temperature is critical. This is judged by the colour of the steel bars, and provision of tubular fluorescent lighting has enabled this visual gauging of the temperature to be made more readily and consistently. W. E. H.

### IV.—LIGHTING EQUIPMENT.

**193. Technique Developed for Fluorescent Lighting of Offices.**

*W. G. Darley.* El. World, 113, p. 1,514, May 18, 1940.

The design and application of lighting fittings are considered with reference to shielding and glare, and examples of calculations are given for determining average lighting intensity and spacing of units. S. S. B.

**194. New Electrical Products.**

*Anon.* El. Rev., Vol. CXXVII., No. 3,271, p. 93, August 2, 1940.

Describes an accumulator A.R.P. shelter lamp, and also gives details, with a sketch, of the new inverted bi-post construction for large-power filament lamps. R. G. H.

**195. Optical Glass.**

*J. G. Holmes.* Phot. J., Vol. 70, p. 301, July, 1940.

A description is given of the preparation of a batch of optical glass, from the raw materials to the cutting and moulding into blanks. Illustrations of the processes are given, and a discussion on the paper is included. R. G. H.

### V.—APPLICATIONS OF LIGHT.

**196. Lighting and the Future.**

*Editorial.* Elect., 125, p. 72, August 9, 1940.

Reference is made to experimental work in America on illuminated guide lines for motor traffic. Tubular lamps are embedded in the roadway with a flush finish of a red transparent plastic material. C. A. M.

**197. Assembly Rooms Lighting.**

*Anon.* Elect., 125, p. 64, August 2, 1940.

Details are given of a lighting installation in Birmingham in which nearly 3,000 ft. of fluorescent tubing are used. C. A. M.

**198. Industrial Lighting.**

*Anon.* Magazine of Light, IX., No. 5, pp. 36-37, June, 1940.

Further instances of the use of tubular fluorescent lamps for industrial purposes are described with photographs. C. A. M.

**199. Works Lighting.**

*Anon.* Elect., 125, p. 69, August 2, 1940.

Problems associated with the lighting of conveyer belts for motor-car-engine assembly are described. In one case lighting for the underside of the conveyer was provided by fittings recessed into the floor beneath. C. A. M.

**200. Artificial Daylight in Factories.**

*C. W. M. Phillips and R. H. Finch.* El. Times, 98, p. 125, August 22, 1940.

The importance of providing natural lighting in factories is emphasised, and a description of a factory installation using laylights equipped with 5 ft. tubular fluorescent lamps is given. The design of suitable laylights is discussed. W. E. H.

**201. Factory Lighting in War Time.**

*Anon.* El. Rev., Vol. CXXVII., No. 3,271, p. 90, August 2, 1940.

A summary is given of the Fifth Report of the Departmental Committee on Lighting in Factories. Lower limits of illumination are given, together with the committee's recommendations for the suppression of glare. R. G. H.

**202. Increased Lighting Helps Another Job.**

*M. W. Ulf.* Magazine of Light, IX., No. 5, P. 21, June, 1940.

In the process of collecting statistical data by manually decoding information cards an increase in the speed of data collection of 20 per cent. resulted from the substitution for 20 ft.c. of general lighting of 50 ft.c. C. A. M.

**203. A Re-Modelled Building.**

*L. E. Fenlon.* Magazine of Light, IX., No. 5, pp. 26-28, June, 1940.

A description is given of a simple conversion of a ceiling of an existing building to modern lighting requirements. False beams were fitted dividing the ceiling into rectangles, in the centre of each of these a pendant silvered bowl lamp with a simple glare shield was fitted. C. A. M.

**204. Cornice Lighting.**

*B. K. Patton.* Magazine of Light, IX., No. 5, p. 25, June, 1940.

An example of cornice lighting employing tubular fluorescent lamps in groups of three in a dining room is shown in some detail. C. A. M.

**205. Lighting Problems in Connection with Air Raid Precautions.**

*W. R. Stevens, J. M. Waldram.* G.E.C. Journal, XI., No. 2, pp. 114-125, August, 1940.

A comprehensive study is given of the problems occasioned by the war in the lighting equipment for many purposes. C. A. M.

**206. Projection Supervision** (H. Rubin); **The Projectionist's Interest in Auditorium Viewing Conditions** (B. Schlanger); **Personal Safety Factor for Projection Practice** (T. P. Hover); **Defects in Projection and their Correction** (I. Gordon); **Records for the Projection Room** (J. R. Prater).

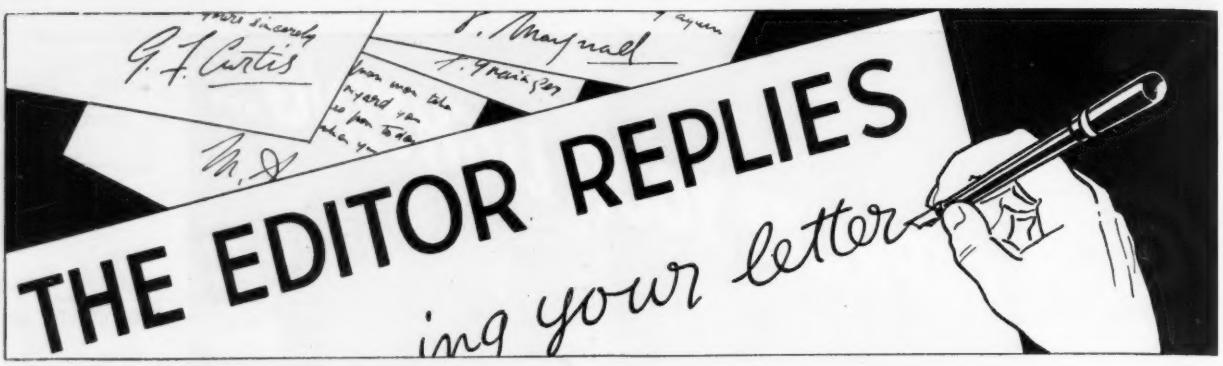
J. Soc. Mot. Pict. Eng., Vol. 34, pp. 580-605, June, 1940.

A series of papers concerned with projection practice in the U.S.A. summarises a number of factors of importance in motion picture work. The keeping of proper records by the projectionist is shown to have advantages, and he is advised to become familiar with the fundamental background to his job. Some of these fundamentals are treated briefly. R. G. H.

**207. The Effects of Utra-Violet Light on Variable-Density Recording and Printing.**

*J. G. Frayne and V. Pagliarulo.* J. Soc. Mot. Pict. Eng., Vol. 34, p. 614, June, 1940.

It has been found that halation and image scattering are reduced by recording and printing sound records with ultra-violet radiation, thus improving the response. The effect of U.V. radiation upon the contrast and development of photographic emulsions is investigated and discussed. R. G. H.




I am still occasionally asked by readers where they can find a simple explanation of polar curves of light distribution, isolux diagrams and, more especially, the **isocandle diagram.** I feel I cannot do better than refer them again to the contribution by Dr. J. T. Walsh entitled "Isocandles for Amateurs," which appeared in this journal in July, 1933.

I also receive inquiries in regard to **photometers and gauges for low illuminations.** Gauges for this purpose are specified in BS/ARP 30 (recently revised), and are made by several firms who habitually advertise in these columns, including Everett, Edgcumbe and Co., Ltd., and Holophane, Ltd. They are quite easy to use, once it is recognised that at such low illuminations the degree of accuracy possible with high illuminations cannot be expected, and that a reasonable time must be allowed for the adaptation of the eye. For those who desire a measurement, as compared with a "stop-go" check, photometers operating at these levels of illumination can also be furnished by the firms mentioned

My comment on the **lighting of interiors of telephone kiosks** has brought a letter from Mr. A. Cunnington, who describes an approved device already in use in quite a number of telephone kiosks on the Southern Railway. An ordinary lamp, enclosed, is provided with a small matt-black rectangular tube, similar to a match case, which is set at an angle and lights a small spot on the telephone instrument and desk. It does not allow any appreciable light to stray beyond the precincts of the kiosk itself. The lamp is best situated in a corner of the kiosk diagonally opposite to the telephone instrument. The use of this device has been approved by the authorities for all kiosks on stations not in the open. There does not seem, however, to be any technical reason, so far as emission of light is concerned, why it should not also be used in kiosks in open stations and in the streets.

I have noticed with interest a contribution to the *Electrical Review* by Mr. E. E. Hoadley, who bears witness to the amenity values of **war time street lighting** (0.00025 ft.-c.) as compared with no light at all and to the change in his original views brought about by demonstrations. Many of those whose first reaction was to conclude that such a low value of illumination is useless have been likewise led to modify their opinion. The most usual criticism, however, has been, until recently, that the illumination is too weak to be effective. It is, therefore, the more surprising to find that, according to the *Electrical Review*, a midland town has recently rejected a proposal to install war time lighting, whilst another has even decided not to put in operation the units already installed! In both cases the consideration is apparently the same as that which recently prompted people in one district to throw stones at the "approved units"—a fear that they can be seen by hostile aircraft. In this matter they might surely accept the view of the Ministry of Home Security, formed after many experiments and long consideration, that lighting complying with BS/ARP/37 may safely be used.

I have been asked to say something on the comparative **resisting power** in air raids of **special forms of glass** or materials applied to ordinary glass windows. On this point considerable differences of opinion seem to exist. When danger of severe and repeated shock has to be met, the use of special toughened glass, glass in which wire is embedded, or hollow glass bricks, all of which have considerable resisting power, is doubtless advisable. The ordinary user is scarcely in a position to guard against the effect of severe blast at close quarters in this way, and must be content with relatively inexpensive means of gaining some protection against the vibratory shock of distant explosions, which is the more usual contingency. Of such devices the application of muslin or a close fabric pattern to a window treated with one of the special protective varnishes, so that it adheres all over, is probably the most effective, though wide and tough tape, reinforced with a second coat of varnish, may be almost equally good. Both involve some loss of light. Simple spraying with translucent varnish is better in this respect, though the protection conferred is no doubt less. Another important consideration is that the resistant qualities of some coatings deteriorate in course of time, and periodical renewal may be expedient. So far as relatively distant effects are concerned all these devices are apparently of some value, in some degree diminishing liability to crack and holding broken glass in position so as to check splintering, though the singular inconsistencies in the effect of shock on windows make it difficult to draw definite conclusions.

From this standpoint the experimental introduction of **protective netting for windows in public vehicles** and certain carriages on railways may be commended. It has, however, one drawback. It is difficult to see out of windows thus treated, especially at night when any light inside illuminates the pattern to some extent so that the surrounding obscurity is intensified. A small aperture to enable passengers to observe progress and recognise their destination might therefore be expedient.

Following my comments last month on **the obliteration of station nameplates** it is encouraging to learn that names will now be permitted, provided that they cannot be read from a highway or by low-flying aircraft. Lettering up to 3 in. in height may now be used in the open. It seems a pity that so many signs that would meet these requirements perfectly well have been obliterated and must now be restored—when the railways have time.

Another suggested remedy—available both in public vehicles and in railway carriages—was recently suggested in the Press, namely, that passengers should join with porters (or conductors) in announcing the point of arrival. Such a chorus, unless carefully synchronised, does not seem likely to aid those who are "hard of hearing," and who always prefer the visible message.

This raises one other point—cannot some **visible signal that an air raid is in progress** be devised. Drivers and occupants of motor vehicles, as well as deaf people, may fail to hear the siren, and—now that a nonchalant bearing during air raids has become so general—a person emerging from a Tube or underground premises may be quite unaware for some little time that a raid is in progress.

May I, in conclusion, use this column to invite secretaries of local centres, and members in other cities, not only in Great Britain, but in all parts of the British Empire, to send us notes of doings and meetings. At such a time as this when communications are so much less easy than in normal times, the printed word remains, more than ever, a valuable means of maintaining contact.

## Modern Lighting for Demonstration Showroom

In a modern demonstration-room good lighting is half the battle. The adjacent picture shows the appearance of the new demonstration-room of the Southport Corporation Electricity showrooms. The offices and showrooms were modernised in 1938, but this demonstration-room has only recently been completed. It is panelled in walnut and has a parquet flooring in light oak. The lighting, devised in collaboration with the General Electric Company, Ltd., comprises rectangular laylights each equipped with nine 75-watt incandescent lamps in dispersive reflectors. A smaller laylight, similarly equipped, is fitted over the stage. Cornice lighting, with a three-colour system in red, green, and blue, is arranged round the room, 15-watt lamps being mounted on 4-in. centres.

A general view of the Southport Corporation Electricity Showrooms showing laylights supplementing cornice lighting.

## War-Time Electric Street Lighting

*Cheltenham.*—Considerable progress has been made with the war-time street lighting scheme, 874 out of 1,086 fittings ordered having been received, while the others are expected shortly. Seven hundred and fourteen lamps are already in use, principally in the main thoroughfares.

*Chester.*—A scheme submitted by the city electrical engineer, Mr. S. E. Britton, for war-time street lighting in a number of streets has been approved.

*Edinburgh.*—The City Lighting Department, which was responsible for the lighting of 20,000 tenement stairways, has already installed a modified form of stair lighting in 10,000 of them. Except in very few cases it has been found possible to screen the lighting effectively, and yet provide reasonable illumination. A nominal charge is made for each fitting.

*Huddersfield.*—War-time street lighting on a limited scale is to be provided for the coming winter.

*Kettering.*—The council has decided to obtain 400 additional war-time street lighting fittings if the manufacturers are able to supply them, at an estimated cost of £300.

*Northallerton.*—The council is to submit its proposals for modified street lighting to the Ministry of Home Security.

*Paisley.*—Following experiments made last winter, war-time street lighting has been provided in the main streets. Orders have been placed for a sufficient number of fittings to extend the scheme throughout the side streets so that practically the whole town will be lighted to war-time standards.

*Stretford.*—A modified street lighting scheme at a cost of £1,700 has been approved.

*Tyneside Towns.*—A conference of local authorities convened by the Mayor of Gateshead, Alderman P. S. Hancock, on August 23, decided to press the Government to sanction the installation of war-time street lighting in the Tyneside area. Although Sir John Anderson stated in the House that it was not possible for lighting to be permitted in this area owing to its proximity to the coast, it was contended that as war-time street lighting in its limited form, and properly installed, was reputed to be invisible from the air, the Government should allow this form of lighting to be installed.

*Wandsworth.*—The borough council has decided to install lighting in accordance with BS/ARP 37 for next winter at a capital cost of £9,473, which will be spread over five years. The Chairman of the Lighting Sub-Committee indicated that their recommendation had not been at all hasty, and that a great deal of useful information had been obtained as a result of trial installations. To reinstate normal lighting after the war would cost the borough £2,000.


An effective display introduced by the British Thomson-Houston Company, Ltd., in which modern lighting in the home, shop, and factory (above the design) is contrasted with bygone methods, illustrated in the side scenes.

## The Appearance of Coloured Lights

The first meeting of the Midland Area Local Centre was held on September 13 at 6 p.m. at the Electricity Showrooms, Paradise-street. In the absence of Mr. Ette, the chair was taken initially by Mr. Long, who introduced the new chairman, Dr. W. M. Hampton.

After the brief official business was completed, the chairman gave his Presidential Address on the Colour Recognition of Point Sources. This was a popular survey of the work that had been carried out over the last two or three years in the research laboratories of Messrs. Chance Brothers and Co., Ltd., on the recognition of coloured lights when viewed as point sources, with particular reference to the areas on the I.C.I. trichromatic diagram which were suitable for signal purposes.

The lecturer first briefly surveyed the principles of colorimetry and emphasised that there was a marked difference between the appearance of a coloured light when viewed at height illumination and as a reasonably extended source, as compared with its appearance as a point. A description was given of the apparatus used, which enabled some 256 different colours to be presented in a random order to some fifty observers, and the result of the 40,000 odd observations, was condensed into the form of diagrams. These diagrams showed the percentage of times a particular point was given a particular name. It was found that the name given depended not only on the illumination, which in the experiments varied from 1 to 3,400 mile-candles, but also on the choice of names permitted to the observer. It is hoped that full details of the work will be published in the Transactions of the Society early next year, together with a detailed description of the apparatus used.

Some 30 members of the section were present in spite of the abnormal conditions prevailing, and a fairly lively discussion followed. The meeting closed at 7.30 p.m.

## Conference on War Time Industrial Lighting

A conference of over 250 lighting engineers recently took place at the E.L.M.A. Lighting Service Bureau. Mr. J. Y. Fletcher presided. The electrical industry has already set up a Joint Lighting Committee with members representing the following associations:—British Electrical Development Association, Electrical Contractors Association, Incorporated Municipal Electrical Association, Cable Makers Association, Incorporated Association of Electric Power Companies, Electric Light Fittings Association, Electric Lamp Manufacturers Association. Of this committee Sir Duncan Wilson is acting as Chairman and Mr. W. J. Jones as Secretary. A memorandum prepared by the technical representatives of the Committee with the object of achieving uniformity of procedure was distributed to those attending the conference.

Sir Duncan, in referring to the fifth report of the Departmental Committee on Factory Lighting, summarised the main conclusions of the report.* It was pointed out that the minimum of 6 foot-candles should not be regarded as sufficient for process working, and that values in accordance with the I.E.S. code should be recommended. Moreover, Section 13 of the Ministry of Supply Act requires "vital" factories to provide illumination up to the standards of this code, with due regard to the provisions of the Factories Act.

In the course of the proceedings demonstrations of values of illumination from ½ up to over 50 foot-candles with tungsten, mercury, fluorescent mercury, sodium and tubular fluorescent lighting were given.

*LIGHT AND LIGHTING, Aug. 28, 1940, p. 125.


An Osram Window Display.

# Electric Lamp Publicity

It is encouraging to observe the familiar seasonal flood of electric lamp publicity. Particulars of showcards, window displays, etc., from most of the chief lamp companies have reached us once more.

Amongst these we note a somewhat elaborate display piece, executed in fourteen colours and entitled "The Nation's Light of To-day," issued by *The British Thomson-Houston Co., Ltd.* Around the centre display of Mazda lamps and this motto are scenes depicting lighting of past ages, whilst modern lighting in the home, shop, and factory is pictured above. Another attractive design bears the motto, "Save by Using Mazda Lamps."

*Crompton Parkinson and Co.* have adopted the motto "You Need a Good Light" in their displays of Crompton and Kye lamps. An effective showcard combines a view of the lamp, with motto, in the background, with silhouetted figures in the foreground. Other slogans relating to Kye lamps are, "Kye in the socket—saves your pocket" and "When you buy, insist on Kye." A feature of Kye counter leaflets is the exploitation of some novel trick or device. This is exemplified this year in the cover of a leaflet depicting a man with his hand in his pocket. When the hand is withdrawn the folder opens, revealing the "story."

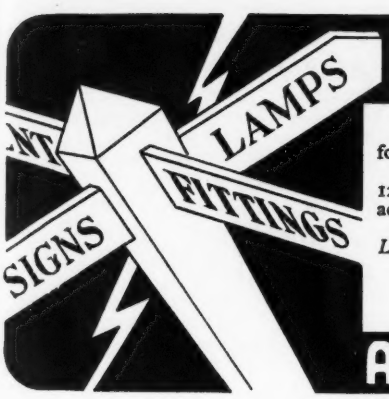
The *Edison Swan* literature likewise makes use of two slogans, "Now, Let's See" and "Be Prepared," the pleasing face of a child being incorporated in several designs. Ediswan also again enters the publicity film field with one-minute features in "The Signs of the Times." The first film, showing graphically how light is measured, was released on August 26.

*G.E.C.* publicity emphasises the fact that scrupulous observance of black-out conditions is no bar to abundant light within. There is also an "Open" sign for use in windows, and a showcard extolling, in familiar fashion, "The Wonderful Lamp."

A calendar issued by *Metropolitan-Vickers Electrical Co., Ltd.*, has a picture of a charming lady. *Philips Lamps, Ltd.*, in addition to designs based on the "See It Through" motto, have a typical picture featuring searchlights and A.R.P. defenders ("At Home We Use Philips Lamps, Too"). A highly enterprising departure is the puppet technicolour cartoon, "Aladdin and his Magic Lamp," now being released for showing in local cinemas—a characteristic five minutes' George Pal production.


A Siemens Window Display: the "Vase" Design.

*Siemens* displays include the "Vase" design (here illustrated), and the "Judge" showcard which was so much admired last year.

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These terms are equivalent to **half our ordinary advertising rates**, but not less than 12 successive monthly insertions can be accepted on this basis, and amounts are payable in advance.

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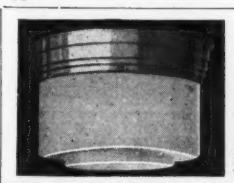

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## INDEX TO "WHERE TO BUY"



*N.B.—The numbers are those attached to individual entries in the Directory*

*(See pp. 173—174)*